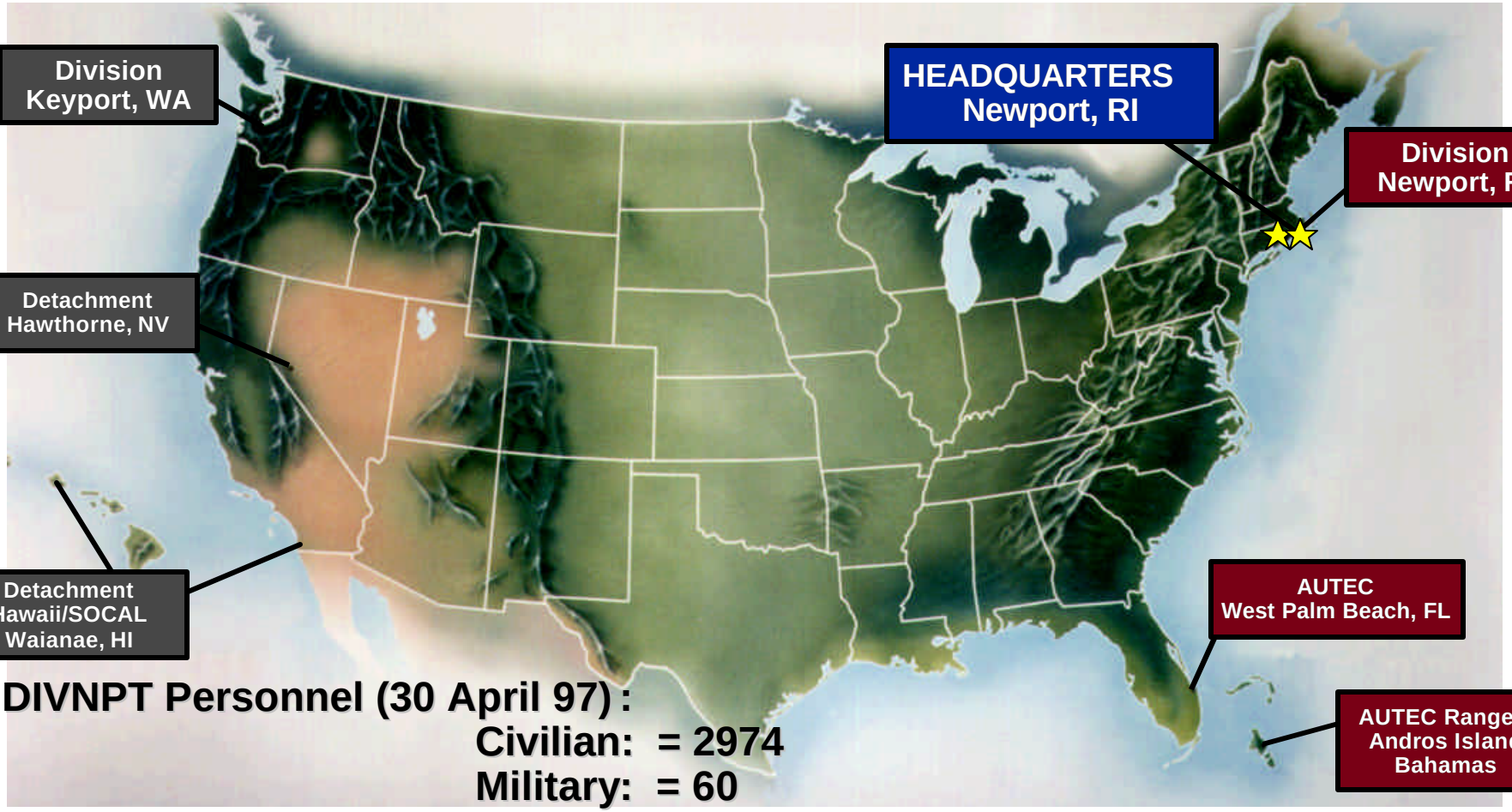
Undersea Warfare Center Division

Naval Undersea Warfare Center

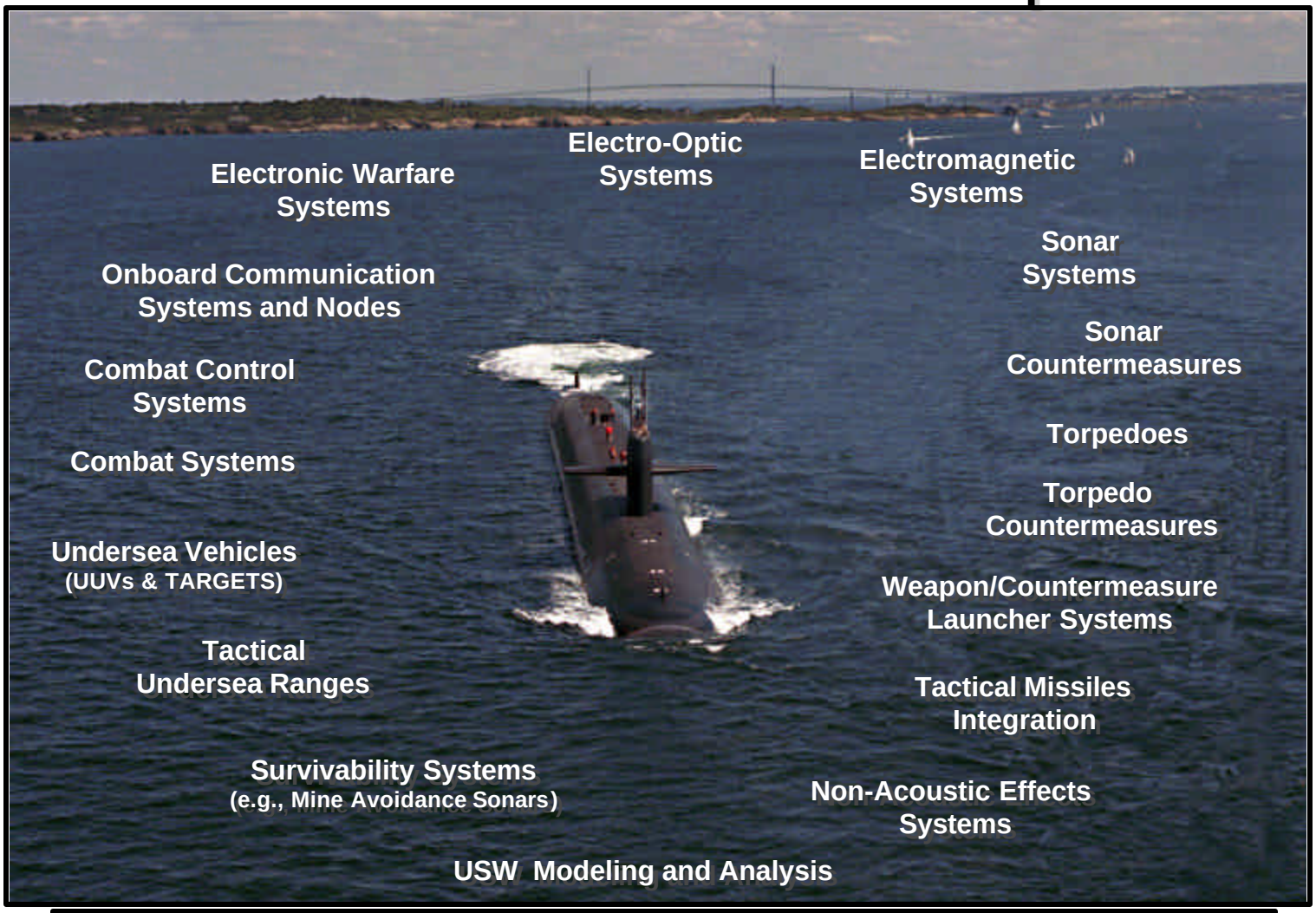


DIVNPT Personnel (30 April 97) :
Civilian: = 2974
Military: = 60

DIVNPT FY97 Annual Budget: ~$750.0M Plant Value / Land: ~$1.3 Billion*
Buildings: ~$526 Million Land Owned / Leased: 1049 Acres**

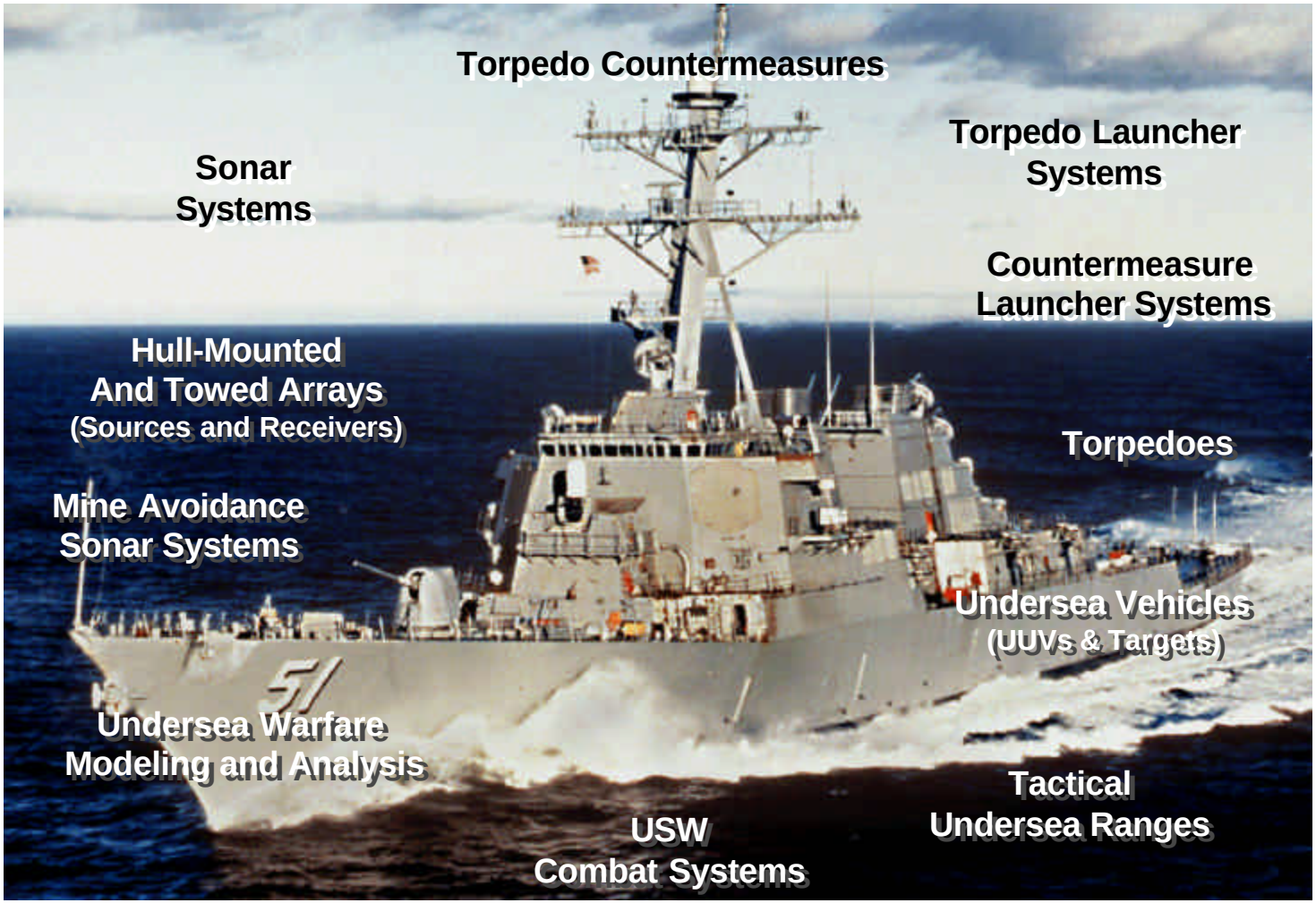
* ACQUISITION COST ** CURRENT VALUE

NUWC Submarine Leadership Areas



Entire undersea warfare system for all submarine missions

NUWC Surface Ship Leadership Areas

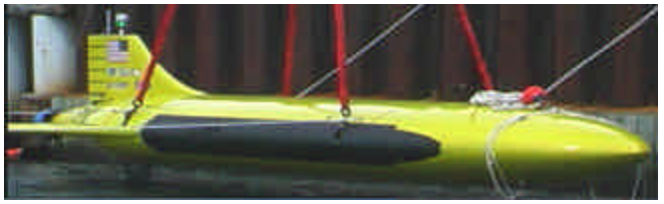


Tactical warfare system for surface ship USW

Electric Propulsion

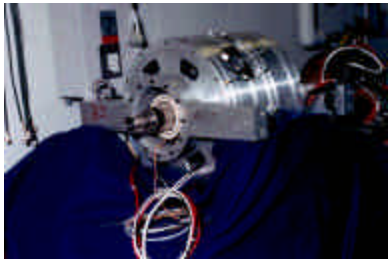
UUV and Torpedo Motor Technology Development

- High Hp Torpedo Motor
- Counter-Rotating
- Forward Only



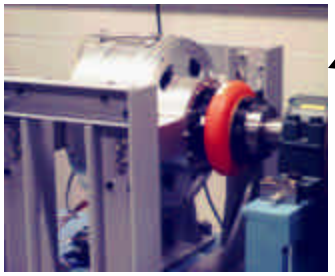
LDATV Motor
1993

- Cots Radial Field
- Counter-Rotating
- 0 - 12 Knots
- Quiet
- Low Cogging Torque



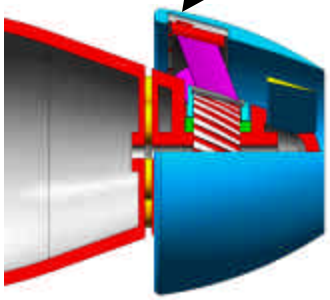
LDUUV Motor System
1995

- Cots Radial Motor
- Single Rotation
- Controller Upgrades
- 0-18 Knots
- Reverse and Hover
- Quiet
- Low Cogging Torque



21UUV Motor System
1996

- Permanent Magnet Motor
- Hybrid Radial/Axial Configuration
- Compact, Lightweight
- Low Cogging Torque



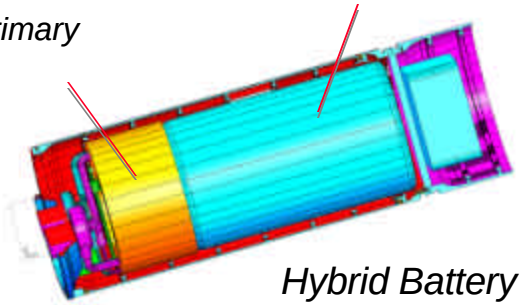
Integrated
Motor / Propulsor
1999

Electric Propulsion Development

Energy

Li - ion Rechargeable

Al-AgO Primary

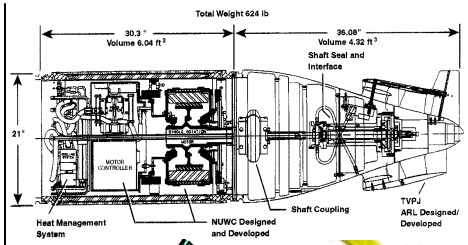


Hybrid Battery

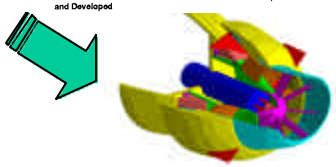
Wakeless, Low Radiated & Self Noise, No-Turnaround Exercise

- High Power Density Primary (Al-AgO) for Tactical Warshot
- High Energy Density Rechargeable for Exercise

Motor



Conventional PM Drive



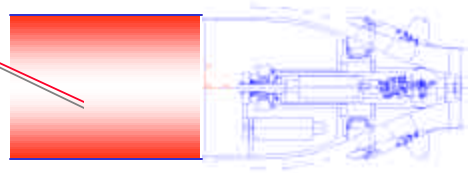
Integrated Motor & Propulsor (IMP)

35% Volume Increase in:

- Increased Payload
- Increased Energy

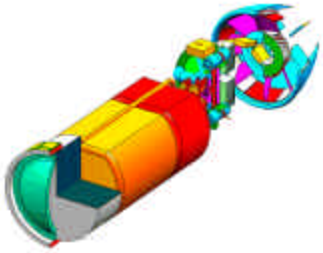
Increased Reliability

- Reduced Machinery Complexity



IMP PM Drive

Payoff for Torpedo



Combined IMP/Hybrid - Affordable, Quiet, Increased Payload & High Performance

Magnet Strength Tradeoff Study

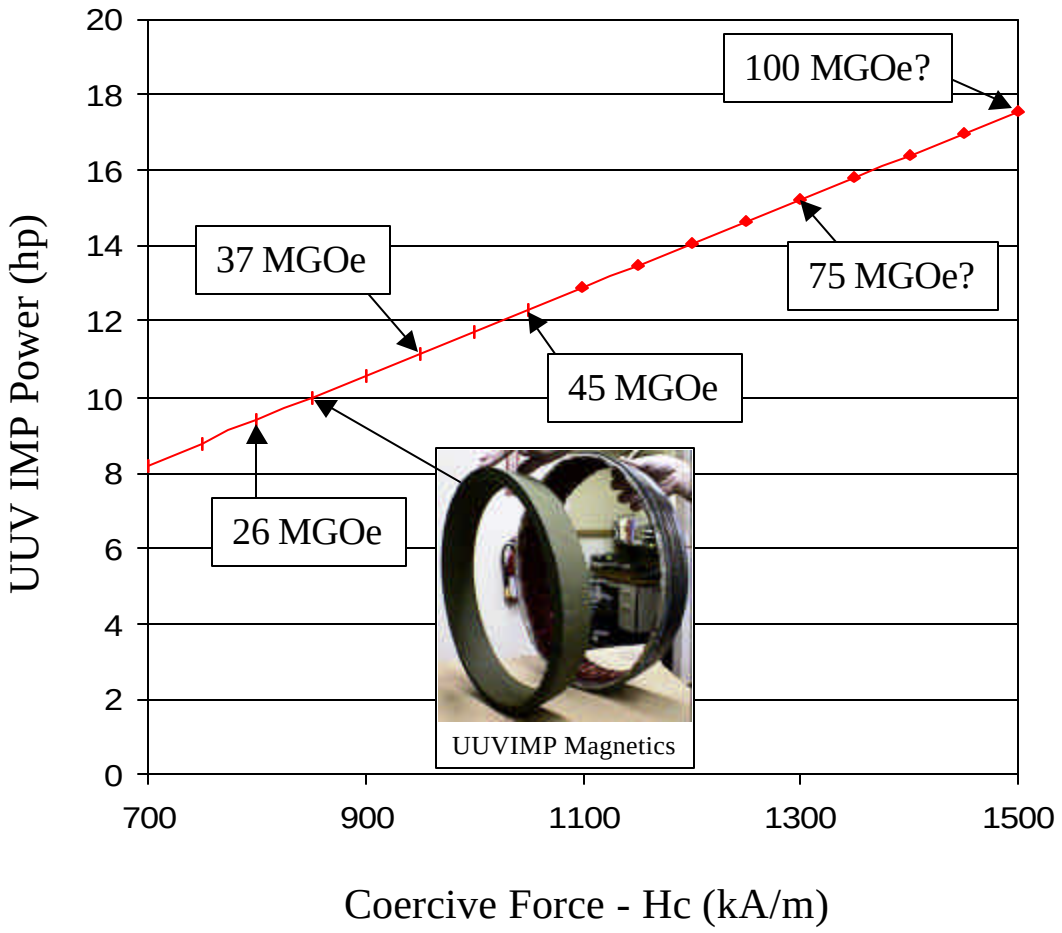
(Unmanned Underwater Vehicle Integrated Motor Propulsor (UUVIMP))

Payoff

- 50% more Coercive Force = 50% more Motor Power
- Torpedo IMP not possible with current State of the Art Magnets
- Makes Concept Feasible for Torpedo Power Levels

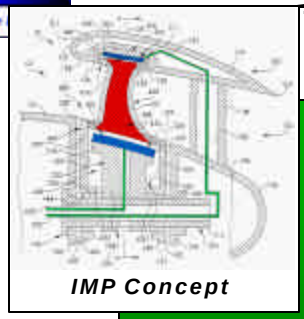
Power v.s. Magnet Strength

(Dimensions and Input Parameters Held Constant)

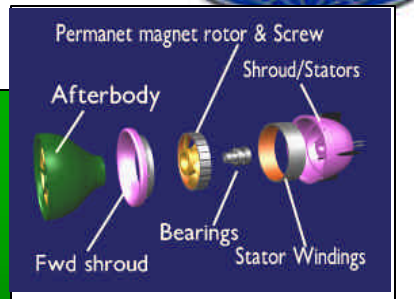


Integrated Motor/Propulsor

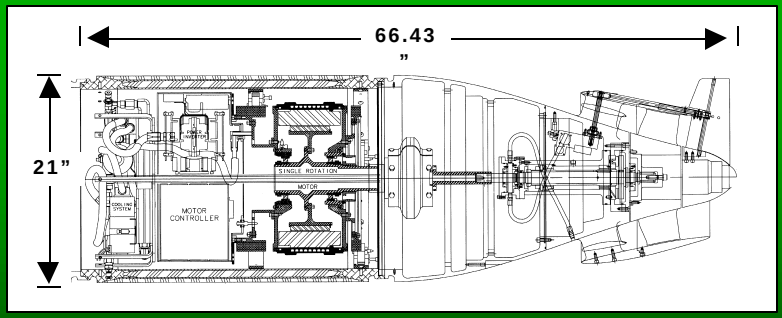
Technical Approach



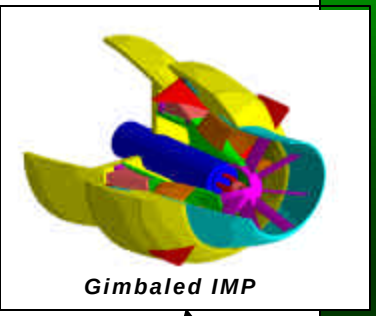
IMP Concept



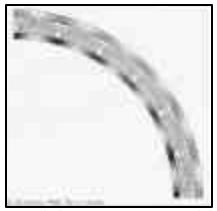
SBD Model



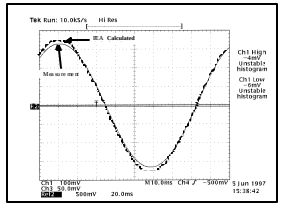
Current UUV Propulsion Arrangement



Gimbaled IMP



2D Slotless PMAC Motor Model



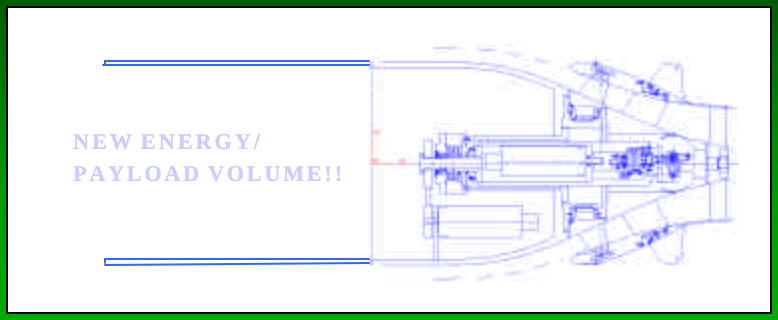
Measured and FEA Calculated Back-EMF Waveforms Comparison

Magnetic Analysis

	Current 21UUV Electric Drive System	Proposed IMP System	Delta	Percentage Saving
Weight (lb)	624	200	424	68
Volume (ft3)	10.36	5.5	5.5	47
Length (in)	66.43	30	36.43	55

Projected IMP Tradeoffs

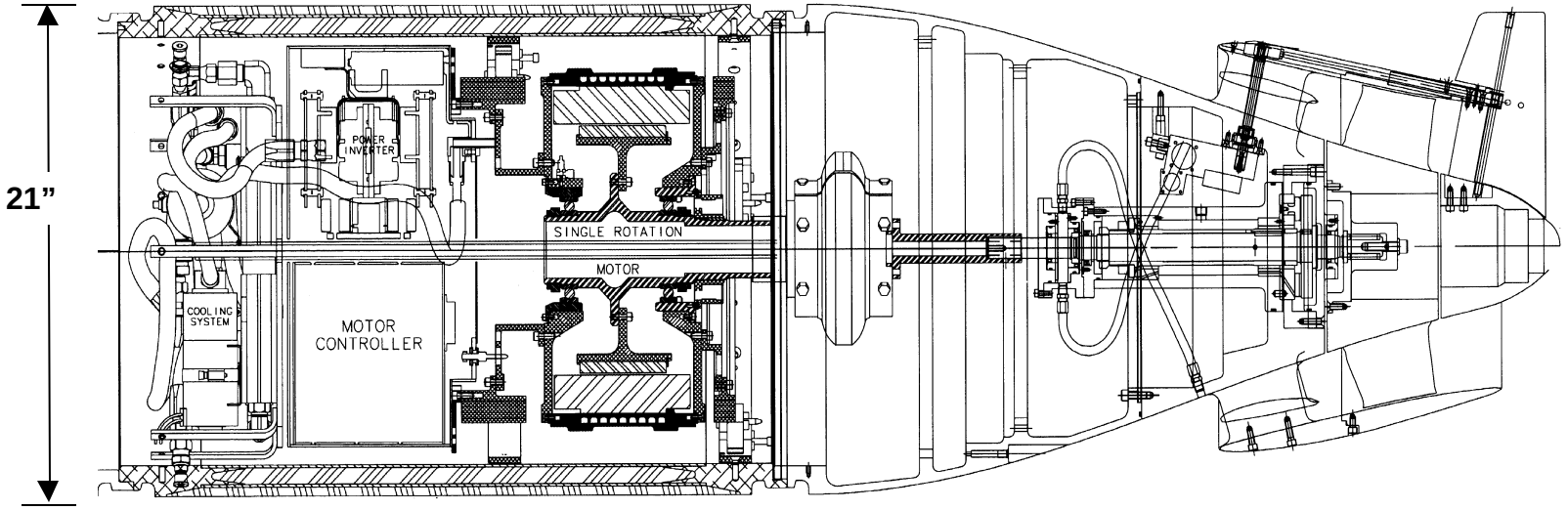
Operational Model



UUV with IMP

Hydrodynamic Analysis

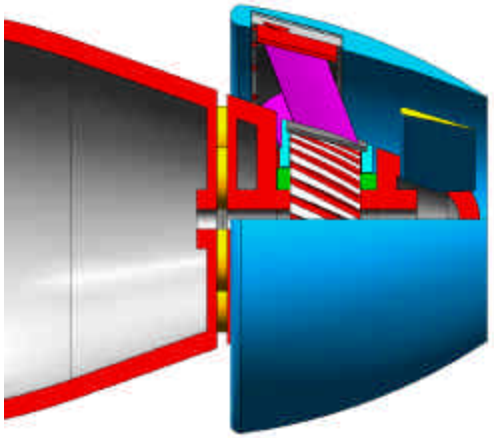
Unmanned Undersea Vehicle Integrated Motor Propulsor



CURRENT 21” UUV ARRANGEMENT **UUV AB/TC: 66.43 inches, 624 lbs**

Payoffs

- Increased Reliability
- Increased Efficiency
- Increased Affordability
- Reduced Maintenance
- Reduced Signatures



Integrated Motor Propulsor:

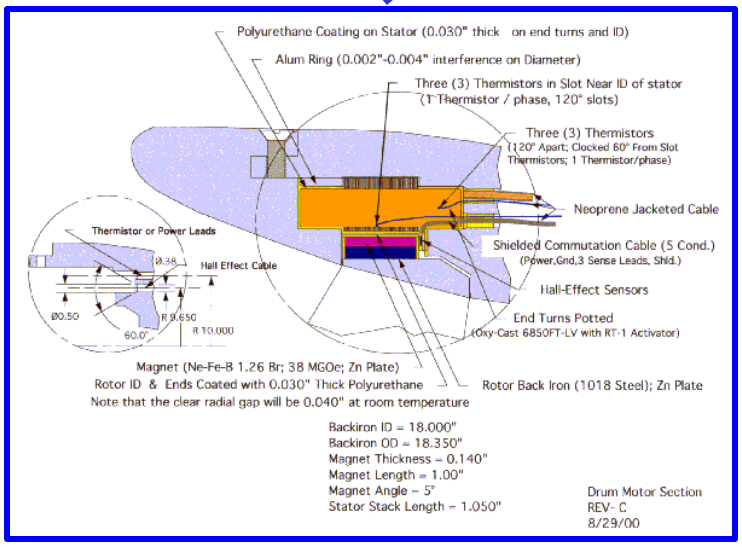
30 inches, 200 lbs

Increases in IMP Power

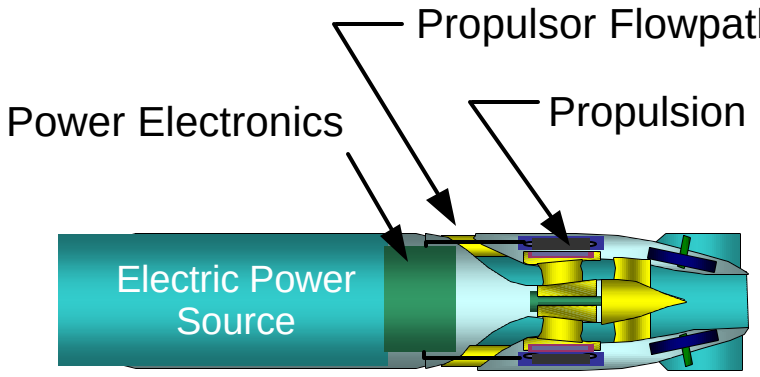
40-hp IMP Prototype

Applications to:

- UUV
- Lightweight Torpedo
- Heavyweight Torpedo
- Submarine Propulsion



10-hp IMP in production



100-hp IMP concept design